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Report describes work performed by Ohio University in the research of a software radio architecture applied to satellite-based navigation receivers.

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Final Report

L1-Band Receiver: Implementation and Performance Analysis

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Final Report for the period 950701 - 960630

Principal Investigator: Michael S. Braasch

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1. Objectives

This research project considers the state-of-the-art in L1-band, satellite-based, spread spectrum ranging systems, and focuses on the performance improvements made possible through higher levels of digitization and signal processing. The goal is to remove as much analog hardware as possible from the receiver front-end and thereby eliminate the temperature and age-based effects which those devices exhibit. In addition, a 'software-radio' design is to be implemented which will provide significant flexibility in receiver design, optimization and operation.

2. Status of Effort

In order to gain insight into the state-of-the-art in L1-band signal processing, two efforts were initiated. The first examined time-domain-based signal acquisition. A literature search revealed that no formal theory existed regarding signal acquisition. Accordingly, the theory behind signal parameter uncertainty was derived and a fast-acquisition algorithm was published [1,2]. This prompted research into frequency-domain-based acquisition algorithms which carry a significant computational burden but hold the promise of extremely fast acquisition times.

In addition, the development of a traditional hybrid analog/digital receiver is on-going. The front-end design is complete and the focus of the effort currently is on the baseband processing. The design is near completion and will be downloaded onto the target hardware (a programmable array logic chip).

Both of the aforementioned efforts provide excellent background which feed the advanced receiver design effort. Through a separate AFOSR supporting grant, hardware has been purchased which allows for direct digitization of the L1-band signal. Software is currently being developed to process this data in a post-processing mode.

3. Accomplishments

As mentioned in the status section, the theory behind L1-band signal parameter uncertainty has been derived and has been published along with a fast time-domain-based acquisition algorithm [1,2].

A novel scheme for direct digitization of multiple information bands has been derived without the need for complex analog hardware [3].

Hardware has been assembled to digitize directly the L1-band signal and software has been developed to acquire the signal and decode the navigation data bits.

4. Personnel Supported

Michael S. Braasch, PI
Dennis M. Akos, Ph.D candidate
Chi-Li Soong, M.S.E.E. student
Azhar Osmanbhoy, M.S.E.E. student

5. Technical Publications

Journal Publications

1. Soong, C., and M. Braasch, "Fast Time-Domain-Based GPS Acquisition," IEEE Transactions on Aerospace and Electronic Systems, submitted June 1996.

Theses and Dissertations

2. Soong, Chi-Li, "Fast Time-Domain-Based GPS Acquisition," M.S. thesis, School of Electrical Engineering and Computer Science, Ohio University, Athens, OH, June 1996.

Conference Proceedings

3. Akos, D., and M. Braasch, "A Software Radio Approach to Global Navigation Satellite System Receiver Design," Institute of Navigation Annual Meeting, Cambridge, MA, June 19-21, 1996.

4. Tsui, J., and D. Akos, "Comparison of Direct and Downconverted Digitization in GPS Receiver Front End Designs," 1996 IEEE MTT-S International Microwave Symposium, San Francisco, CA, June 16-21, 1996.

6. Interactions/Transitions

6.1 Conference Presentations

M. Braasch, "A Software Radio Approach to Global Navigation Satellite System Receiver Design," Institute of Navigation Annual Meeting, June 1996.

D. Akos, "Comparison of Direct and Downconverted Digitization in GPS Receiver Front End Designs," IEEE MTT-S International Microwave Symposium, June 1996.

6.2 Transitions

We have been working closely with Dr. James Tsui of the Avionics Directorate at Wright Laboratory. Dr. Tsui is conducting a parallel effort in advanced receiver design and we meet on a monthly basis to discuss findings. In addition, Dennis Akos, Ph.D. candidate, has received a fellowship to work with Dr. Tsui on site at WPAFB for the summer (1996).

7. Patent Disclosures

None

8. Honors

None